INSTRUCTION MANUAL

NO. 6431

BARBER COLMAN

Wheelco Instruments

model 401C & 401XC CAPACITROL

MP MASTER
MA32125

WHEELCO INSTRUMENT DIVISION
BARBER-COLMAN COMPANY, ROCKFORD, ILLINOIS

TABLE OF CONTENTS

INSTRUCTION MANUAL — MODEL 401C and 401XC INDICATING CONTROLLER

	Page
Unpacking Instrument	3
Mounting Instructions	3
Mounting Dimensions	3
Power Wiring	4
Thermocouple Wiring	5
Meter Shunt Wire	5
Line Compensating Resistor	6
Thermocouple Break Protection (TCB)	6
Meter Adjustments and Check	7
Control Specifications	8
Description of Electronic Circuit	8
Operation	8
Control Adjustment	9
External Wiring Diagrams	10
Internal Wiring Diagram	11
Meter Maintenance and Servicing	12
Control Maintenance and Servicing	13
Suggested Replacement Parts	14
Warranty	15

NOTE: This instruction manual to be given to persons responsible for installation and maintenance of this instrument.

UNPACKING INSTRUMENT

This Wheelco Instrument and its associated equipment have been carefully manufactured and packed at the factory. Remove the instrument and accessories from the packing box and check items against the packing slip. If the equipment is found to be damaged in transit, report extent of damage to the carrier immediately. Repack in original packing box until ready for installation.

CAUTION:

Handle with care.
Safeguard instrument from shock.
Avoid oil accumulation.
Keep instrument temperature under 130° F.

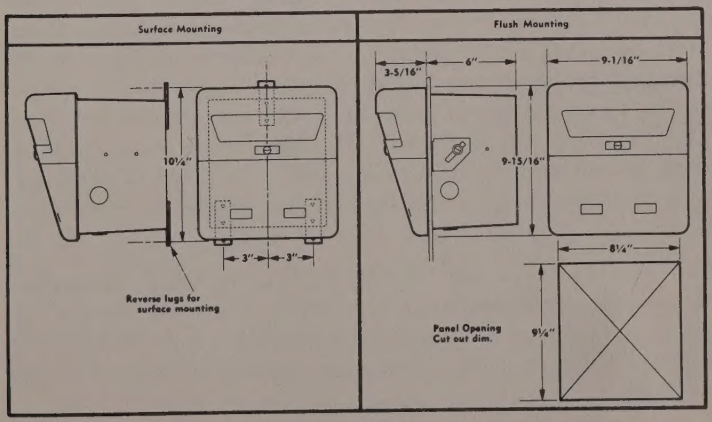
MOUNTING INSTRUCTIONS

Locate the instrument to avoid shock, excessive vibration, moisture and temperatures over 130° F. Avoid furnace walls, radiation of heat, machine frames and outside walls. Provide suitable shelter to avoid moisture and temperature extremes if installed outdoors.

For surface mounting, reverse the three lugs on the back of the instrument housing. See the mounting surface mounting dimension drawing.

For flush or panel mounting, remove the brackets on either side of the instrument housing, insert the instrument through the panel opening, replace the brackets and tighten firmly. See the flush mounting dimension drawing.

MOUNTING DIMENSIONS

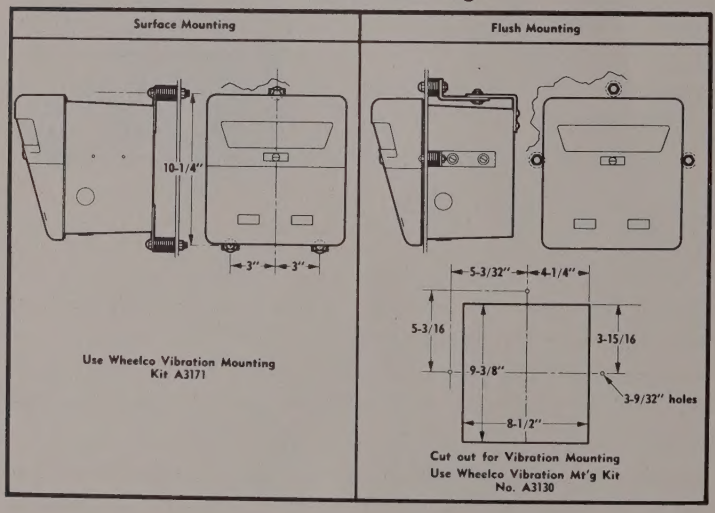


Vibration mounting kits should be used if the vibration causes erratic temperature readings or control. See the vibration mounting dimension drawing for details of surface or flush mounting. Special provisions may have to be considered if the instrument is subjected to severe shock such as from a drop forge or similar type of equipment.

Moderate care should be taken to mount the instrument level.

MOUNTING DIMENSIONS

Vibration Mountings



POWER WIRING

Remove the lower section of the front cover to expose the terminal strips and the control chassis. To expedite wiring, grasp the side plates of the chassis and pull forward to remove. Check the rating plate on the chassis for the supply voltage and frequency. Connect proper voltage and frequency to terminals L1 and L2. Supply voltage should be 105 to 125 volts AC or 210 to 250 volts AC depending on chassis specifications. Run all wiring in rigid conduit, BX or Greenfield, in accordance with the recommended electrical code. Use properly fused switches, see diagram.

Solid wire (14 ga.) is recommended for instrument wiring. If stranded wire is used, tin the ends to provide secure connections. Position the wires so they do not interfere with control chassis or the housing gaskets. Ground the instrument case; a grounded conduit system is usually sufficient.

THERMOCOUPLE WIRING

Do not run thermocouple lead wire with other power or control wiring except for thermocouple break (TCB) wires, if used. Several thermocouple lead wires may be run in the same conduit if desired.

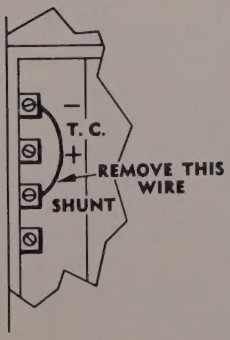
Use only extension lead wire correct for the type of thermocouple (TC) as specified on the scale. The most commonly used types are: Iron-Constantan (I/C), Chromel-Alumel (C/A), Platinum-Platinum 10% Rhodium (Pt/Pt 10% Rh), Platinum-Platinum 13% Rhodium (Pt/Pt 13% Rh) and Heat-Eye. Ordinary copper wire will NOT serve the purpose.

Proper polarity (+) and (—) of the lead wire must be observed to obtain correct readings. The negative wire is usually coded red. Correct polarity of the lead wire can be checked by heating a temporary junction of the lead wire far end. Deflection of the indicator upscale indicates correct polarity of the lead wire.

The thermocouple should then be connected to the lead wire and the indicating pointer should again deflect upscale when the thermocouple hot junction is heated. If the indicator moves downscale, reverse only the connections at the thermocouple head since the lead wire has already been correctly connected to the instrument.

Connect the plus lead of the wire to the plus (TC+) terminal on the chassis. Use a jumper from chassis INST + to + (TC) on terminal strip. Locate the lead wire so it does not interfere with the control chassis or housing gaskets.

METER SHUNT WIRE



After the instrument is installed, disconnect the jumper wire across terminals "Shunt" and "TC—". This wire is used to shunt or dampen the meter movement for protection during shipping, installation and handling of the instrument but should be removed for normal operation.

NOTE: Replace this shunt wire when handling or reshipping the instrument and position the red control point indicator to the top of the scale.

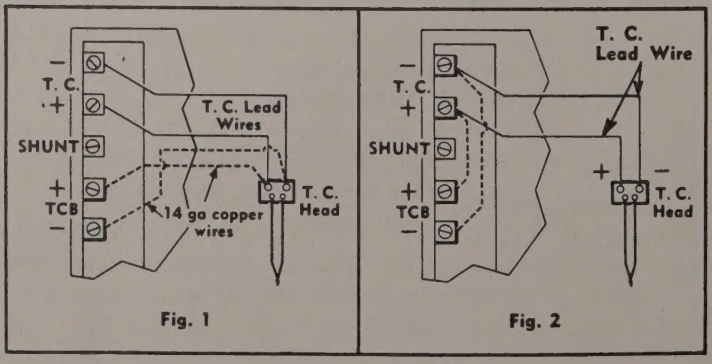
LINE COMPENSATING RESISTOR (A3152)

The external resistance, combined resistance of the extension lead wire and thermocouple, for which the meter has been calibrated is marked on the meter scale. Most meters are calibrated for 15 ohms (Ext. Res. 15 ohms) which is more resistance than most lead wire runs. The balance of the resistance, 15 ohms minus the actual external resistance, will be inserted on a removable resistance strip located just under the meter section. The resistance value is marked on the strip and is inserted at the time of the original order. Other values are available, however, lead wire length can be changed up to 25 ft. without appreciable error in reading because a high resistance movement is used.

THERMOCOUPLE BREAK PROTECTION (TCB)

The instrument is equipped with thermocouple break (TCB) protection. Essentially it is a small DC voltage that can be wired into the thermocouple circuit to drive the movement upscale in case of an open circuit in the thermocouple, thus passing the control set point and causing the instrument control to go to the off position. It is not necessary to make the TCB connections for normal operation of the instrument, but its use may be desirable on some applications to guard against overheating in event of an open thermocouple.

The preferred method of connecting TCB is shown in Fig. 1. Use extension lead wire as required to make the connections between the instrument TC terminals and the thermocouple head. Use 14 gauge copper wire to connect the TCB terminals to the thermocouple head, observing polarity. Wiring for TCB may be run in the same conduit with thermocouple lead wire. As the resistance of the thermocouple is low compared to the resistance of the meter movement, TCB compensation is seldom required.



The optional method of connecting TCB is to use jumpers at the instrument terminals as shown in Fig. 2. As the length of lead wire used affects the amount of TCB compensation required, it is suggested that this method be used with short lead wire lengths, 10 ft. or less and that the amount of TCB error be checked. See section on Meter Adjustments.

To check for TCB operation, disconnect the thermocouple to simulate a broken thermocouple but leave the TCB wires connected to the lead wire. When the instrument is powered, the indicator should drive upscale above the red control set pointer to cause the control to go to the off position.

TCB is not effective on Heat Eye (radiation head) calibrations because of the compensating network in the Heat Eye.

Model 401 XC is not equipped with TCB.

METER ADJUSTMENTS AND CHECK

After the instrument is mounted, check for the cold junction reading of the meter. Disconnect the lead wire at the instrument. The indicator should come to rest at the ambient temperature of the meter; it is NOT supposed to read zero. Place a thermometer at the TC instrument terminals to read ambient temperature.

If the pointer does not come to rest at the ambient temperature, slowly adjust the screw located on top of the front plastic cover. As the meter has automatic cold junction compensation, it is not necessary to make further corrections as the ambient temperature changes.

To check for thermocouple break error (TCB) if it is connected, it is best to have a steady temperature at the hot junction of the thermocouple. Read the temperature at the indicator. For exact reading, position the eye so the reflected image of the pointer on the mirrored strip disappears behind the pointer itself. This reading to be made with power on the instrument. Then disconnect power to the instrument, remove the control chassis, or disconnect the wires at the TCB terminals and note if the indicated temperature drops. Reconnect to see if temperature rises. If a shift in reading is noticed, usually a small amount if any, adjust the screw on the top of the plastic cover, so the reading with TCB powered is at the same point as read with TCB disconnected. If an adjustment was made, the ambient temperature reading will also shift a like amount.

CONTROL SPECIFICATIONS MODEL 401C

The Model 401C is an on-off or two position controller employing a S.P.D.T. switch with a contact rating of 5 amperes at 115 volts or 2.5 amperes at 230 volts AC for a non-inductive load such as a small electric heating element. For inductive loads as solenoid valves or contactor coils, decrease rating 50%. The control action occurs when the meter indicator crosses the red control set pointer.

The control point can be adjusted through the full length of the instrument scale by means of a setting knob located just below the instrument scale. The knob is easily adjusted and is protected against accidental shifting. Red and green signal lights indicate if the temperature is below or above the control set point. The relay contacts are connected to terminals 1, 2, and 3 on the terminal strip.

The control chassis includes a Capaciline circuit to minimize over and undershooting at the control set point.

DESCRIPTION OF ELECTRONIC CIRCUIT

The Model 401C is a development of original Wheelco design. A small vane or flag is mounted on the indicating pointer. Two flat coils are mounted on the control set arm. As the flag passes between these two coils, the plate output of an oscillator circuit changes the current to the coil of the instrument relay. The relay contacts actuate the controlled mechanism. Jacks are provided to facilitate checking the voltage across the relay coil.

OPERATION

The control set pointer is adjustable by use of the knob just below the indicating scale. The indicating pointer will move to indicate the temperature at the thermocouple.

Normal control operation occurs after approximately a 20 second warm-up period. During the warm-up period, the green signal light is on and terminal 2 on the terminal strip is made to terminal 1. After the warm-up period, if the indicator is below the control set point, the red light will turn on and terminal 2 will be made to terminal 3 to turn on the heat. Terminals 1 - 2 - 3 represent an isolated switch and is not powered internally. As the indicator crosses above the red control set pointer, a switch action occurs to turn off the red light and turn on the green light and to open terminals 2 and 3 and make terminal 2 to 1.

This control action will cause the heat to turn off and allow the process to cool. The instrument will turn the heat on and off as the indicator crosses the control set point. The capaciline circuit will pulse the indicating pointer back and forth across the control pointer.

CONTROL ADJUSTMENTS

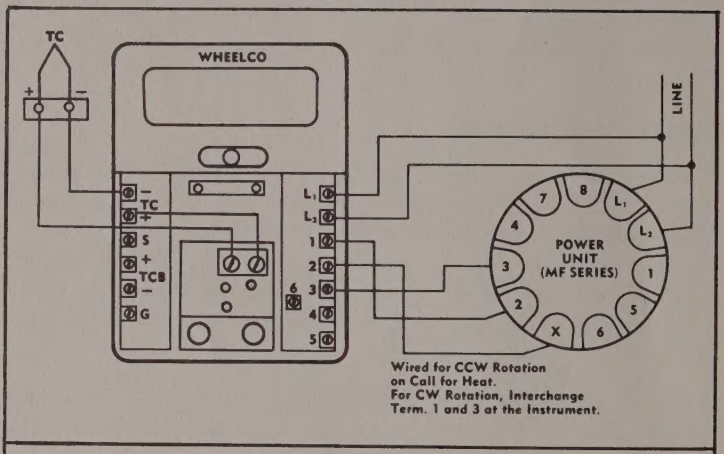
A control adjustment is located on the front of the control chassis and is accessible after removing the lower front cover of the instrument. This adjustment provides a means of aligning the control action with the indicator. If the control action does not occur at coincision of the meter indicator and the red control set pointer, an alignment adjustment should be made. Use a small screw driver to position the tuning condenser.

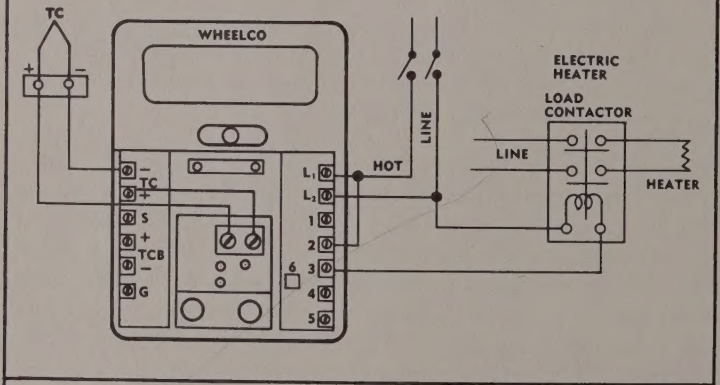
For initial adjustment, position the red control index well above the meter indicator and turn the condenser completely clockwise. Then turn very slowly counter-clockwise until the red signal light turns on. For final adjustment, move the red index slowly past the meter indicator and make small adjustments until the red signal light goes on when the indicator is just below the red index and the green light turns on when the indicator is just above the red index.

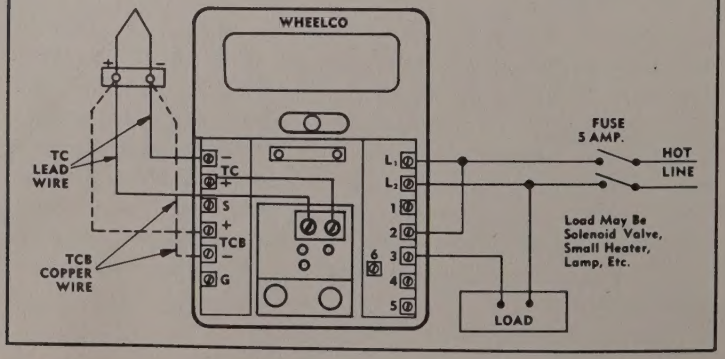
An adjustable slug capacitor is located close to the electronic tube. It is factory adjusted to require approximately a .006 in. motion of the pointer to cause the control action to change from ON to OFF. This setting handles the majority of applications. If it is desired to widen the operating differential of the instrument relay, use a small screw driver and turn clockwise to cause the slug to go deeper in the capacitor. To narrow the operating differential, screw to the left or counter-clockwise. Too narrow an operating differential may cause a chatter of the instrument relay.

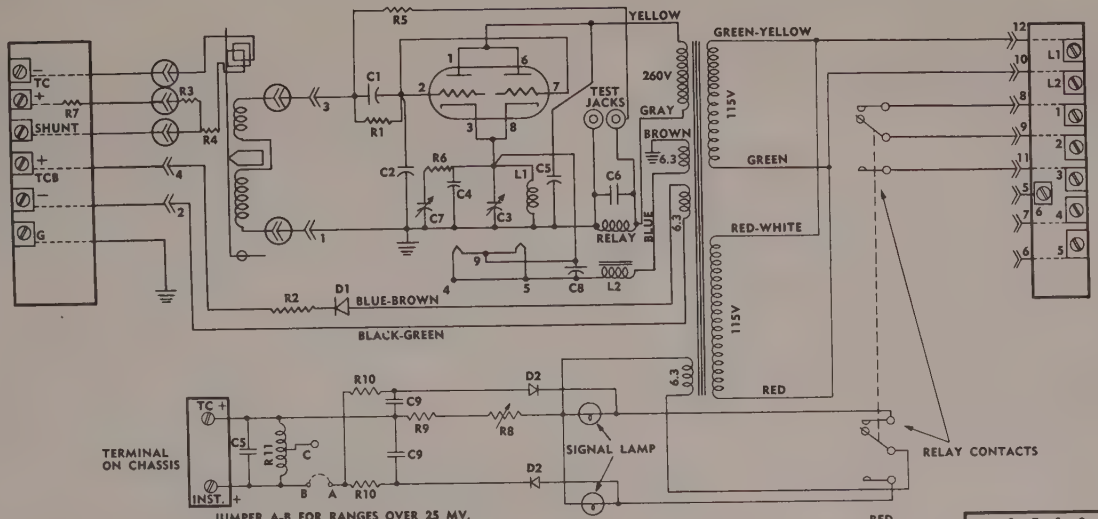
The capaciline effect or rate of cycling can be adjusted by a rheostat located on the front of the chassis marked CYCLE RATE. Turn CW or to the right to increase capaciline action or CCW to decrease. For initial setting, adjust for minimum effect. Allow a reasonable time to determine how much the control has been affected before making the next adjustment. While the capaciline adjustment is not critical, an over correction as well as an under correction may cause deviation from straight line control. Favor a slow rate to avoid excessive contactor wear. Properly adjusted, it is seldom necessary to readjust for changing operating conditions.

EXTERNAL WIRING DIAGRAMS









R1	4.7 MEG	CYZR 170-18	R9	4.7K	CYZR 170-3	C6	8 MFD	CYZR 327-1
R2	LEAD COMP. RES.	A3152	R10	47K	40-070-2	C7	1-8 MMF	39-011
R3	CAL. RES.	A1847	R11	10 CENTER TAP	A3633	C8	.001 MFD	39-063
R4	TEMP. COMP. RES.	A3049	C1	.02 MFD	39-062	C9	100 MFD	39-092
R5	8.2 MEG	40-089	C2	15 MMF	39-109	D1	RECT.	37-009
R6	560	CYZR 170-52	C3	8-50 MMF	39-105	D2	RECT.	37-006
R7	27,000	CYZR 170-7	C4	62 MMF	39-087	TUBE	12 AU7	GYZP 70-9
R8	0-50K	29-042-1	C5	.0047 MFD	39-088	L1	COIL	41-120-1
						L2	CHOKE	30-083-1

METER MAINTENANCE AND SERVICING

While the 400 Series instrument is well designed and manufactured of high grade components, it is worthwhile to have information for emergency servicing. Where a number of instruments are located in the same area, many parts are interchangeable and allows a minimum inventory.

In event of trouble, the serviceman should familiarize himself with the process and instrument application to ascertain the exact function of the instrument as applied. The trouble usually can be traced to two basic problems, measurement or control.

If the measured temperature is known to be in error, check the following:

(1) Open thermocouple circuit, such as break in thermocouple or lead wiring.

(2) Deteriorated T. C. hot junction due to burning.

(3) Shorted, grounded, or damp lead wire or thermocouple except the thermocouple hot junction may be grounded.

(4) Correct polarity of lead wire and thermocouple.

(5) Check for vibration or shock.

(6) A calibration check for meter accuracy can be made with a Wheelco Portable Model 330 or equivalent.

(7) Do not oil or grease any part of the instrument.

In event it is found necessary to remove the plug-in meter assembly, follow these steps:

(A) Remove control set point knob (Bristol #6 wrench).

(B) Remove the four cover screws.

(C) Remove cover straight forward to prevent damage to internal meter parts.

(D) Loosen the two screws in lower meter chassis corners.

(E) Insert fingers behind the two lugs and pull forward carefully to avoid sudden jarring.

(F) Place a jumper wire across the prongs on the back of the meter to dampen the movement.

(G) Position the red pointer to top of scale.

(H) As the meter is exposed, avoid dirt and metal chips.

Reassembly is of reverse procedure, being careful to line up the slotted lever for the zero adjustment pin when replacing the meter cover. Recheck for ambient temperature setting as previously described.

CONTROL MAINTENANCE AND SERVICING

If the control does not function properly and the temperature does not stay at the control point, check the following:

(1) Check power to the instrument. Should be 105 to 125 volts AC or 210 to 250 volts AC depending on chassis specifications.

(2) Replace electronic tube. Two jacks are provided to read voltage across the relay coil. With the red control index well above the meter indicator, the DC voltage should be 90 to 125 volts. When the red index is below the indicator, the reading should be 15 volts or less. These specifications are for an acceptable tube. Check line voltage if readings differ too much.

(3) Relay limits can be checked by moving the red control index slowly across the indicator. Relay pull-in voltage is 60 to 80 volts DC, drop-out is 30 to 50 volts DC. These readings can be noted as the signal lights operate.

(4) Replace chassis. Take advantage of the interchangeable plug-in components if other instruments of the same type and voltage are available.

(5) Check external circuit for sticking valves or contactors, fuses, grounded or shorted wiring, etc.

(6) To alter the control chassis in the field for a different line voltage, change the transformer primary connections per the following: (Also see internal wiring diagram).

230 volt:

Red to pin 10 (L2)
Green-Yellow to pin 12 (L1)
Connect Red-White to Green and tape.

115 volt:

Red and Green to pin 10 (L2)
Red-White and Green-Yellow to pin 12 (L1)

(7) Tube number 5814 can be used in place of EYZP 70-9 (12AU7) if desired.

(8) Pilot or signal lights are #51 Mazda bulbs.

(9) Connect a grounding wire to the "G" terminal if the instrument is ungrounded.

SUGGESTED REPLACEMENT PARTS

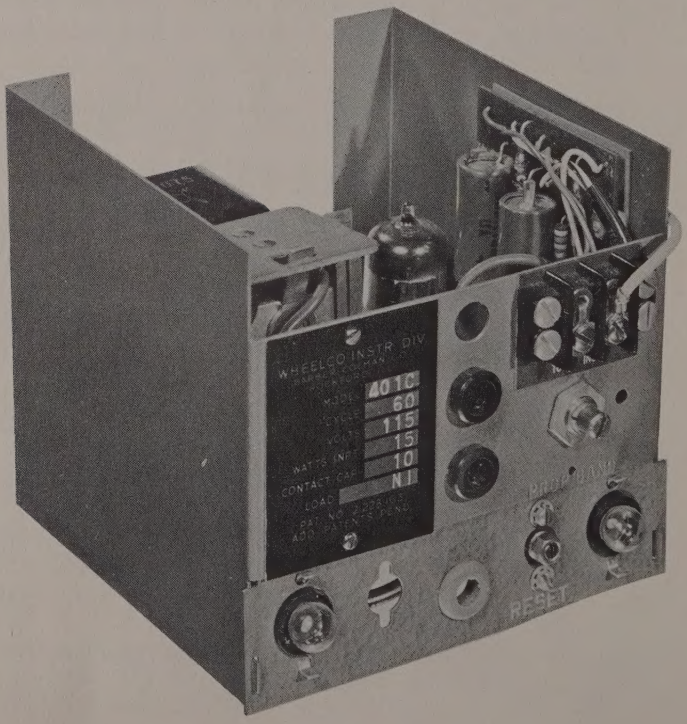
It is suggested that a few spare parts be carried by the user to insure against possible emergencies and accidental damage. These are listed in the order of probable relative need:

	Part No.
*Electronic tube 12AU7	EYZP 70-9
Thermocouple	
Mazda pilot lamps (#51)	36-022-1

Chassis complete with 12AU7 tube for:

For Model 401C—115 V/60C	A3595
For Model 401C—230 V/60C	A3596
For Model 401XC—115 V/60C	A3453
For Model 401XC—230 V/60C	A3454-1

*NOTE: We recommend purchase of the 12AU7 tube from the Wheelco Instruments Division, Barber-Colman Company, to insure instrument functioning as designed. Tube 5814 can also be supplied.



MATERIAL WARRANTY: All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge, if returned immediately, prepaid to the factory at Rockford, Illinois. The seller shall not be liable to the purchaser, or to any other person, firm or corporation for any direct, indirect or consequential damages or injury of any kind or character; that by acceptance of such equipment the purchaser shall accept and assume all liability for any and all damages or injuries that may result from the use or misuse of such equipment by the purchaser, or by any other person, firm or corporation; and that there shall be no other warranty whatever, expressed or implied, with respect to such equipment.

Warranty . . .

Please fill out the Warranty and Inspection Card and return, postage paid.

Warranty and Inspection Card — PLEASE FILL OUT AND RETURN

This equipment is guaranteed in accordance with the statement of warranty appearing on our quotation and acknowledgement forms. Upon receipt of this card properly filled out Warranty becomes effective. All Wheelco instruments are manufactured to the highest standards of quality and are carefully inspected before packing. Instruments which have been damaged or fail to operate upon installation, should be reported to the factory at once.

Wheelco Instruments Division
Barber-Colman Company

MODEL NO.	Date Received
	Company
SERIAL NO.	Street
	City Zone State
CALIBRATION INSP.	By Title
	COMMENTS
FINAL INSPECTION	

F-5396

MP MASTER
MA32125